Energy & Store Development Conference

E+SD 2014

September 7-10, 2014
St. Louis Union Station Hotel
St. Louis, MO

FMI®

THE VOICE OF FOOD RETAIL

Commissioning Refrigeration Systems: From Design Through Operations

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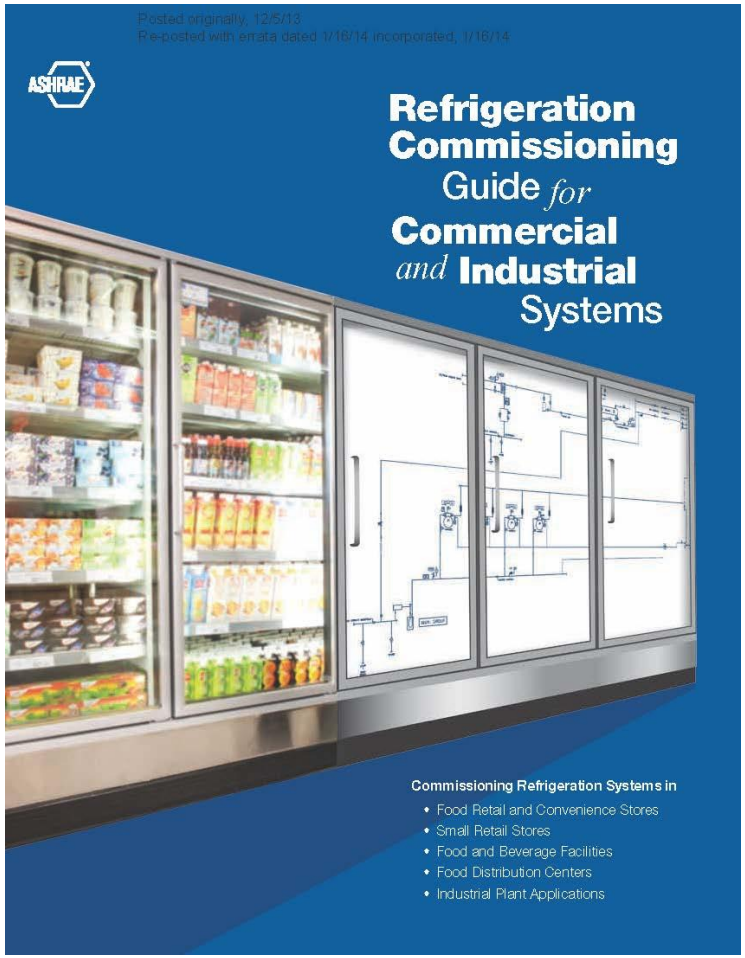
National Renewable Energy Laboratory
Caleb C. Nelson, P.E.
CTA Architects Engineers
Neil Monson
Target Corporation

Guidance for Commissioning



Opportunities for Refrigeration Commissioning

- Refrigeration is every where!
  - Every convenience store
  - Every grocery store
  - Restaurants
  - Many box retailers
  - Warehouses
  - “Cold” supply chain

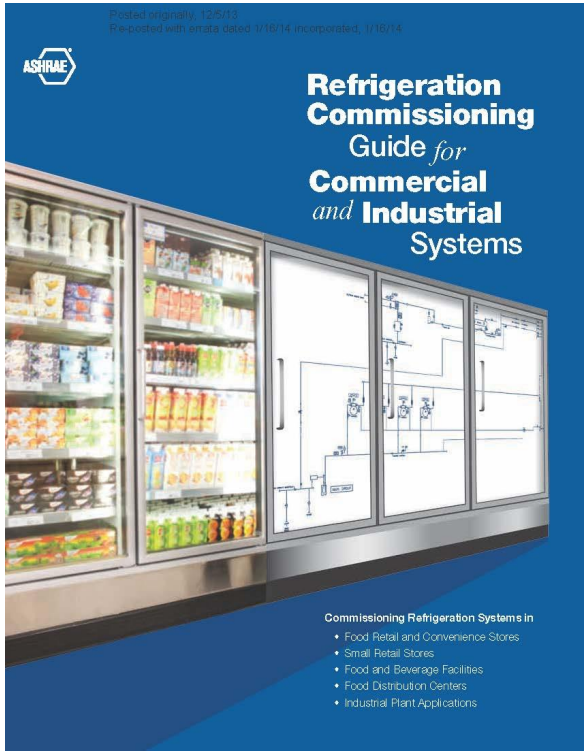
Impact of Refrigeration Systems

- Account for a significant portion of commercial building energy use and are often the largest energy end use in grocery stores
- Commercial refrigeration uses 1.23 quads of energy per year
  - Approximately 7% of all commercial building energy use
- Supermarkets typically use approximately 3,000,000 kWh of electricity per year
  - 60% of that energy use is refrigeration

Refrigeration Commissioning Guide

- Commissioning in existing grocery stores could result in 7% to 25% energy savings per year
- Commissioning is crucial to proper refrigeration system *design*, installation, and operation
- Guide available as a free download from

https://buildingdata.energy.gov/cbrd/resource/1396



Development Process

- 14-member project committee with broad industry expertise
- Development of the guide took about 1 year
- Two peer reviews
- Joint effort between ASHRAE Refrigeration Committee and DOE Better Buildings Alliance
- Guidance document—not a standard

Project Committee

- Richard Royal—Chair
  - Wal-Mart Stores, Inc.
- Bryan Beitler
  - Source Refrigeration and HVAC
- Jon Edmonds
  - Edmonds Engineering Co.
- Timothy Gwyn
  - DC Engineering, PC
- Larry Meeker
  - Target
- Scott Moore
  - PECI
- Caleb Nelson
  - CTA
- Doug Scott
  - VaCom Technologies
- Scott Smith
  - Hillphoenix
- Paul Torcellini
  - National Renewable Energy Laboratory
- Robert Uhl
  - Safeway, Inc.
- Jim Vannan
  - Winn-Dixie
- Lilas Pratt
  - ASHRAE Staff Liaison
- Bert Etheredge
  - ASHRAE Staff Support

Contents

- Preface
  - The business case for commissioning – a message to owners
- Commissioning during Planning and Design
- Commissioning during Construction and Installation
- Commissioning during Start-up and First-year Operations

The Need for Commissioning

- A process of mitigating change and management risks
- Document, measure, manage, and adjust
- Integrated commissioning process gives quick visibility to issues
- Defining owner's project requirements
- Defining basis of system design
- Reconcile construction documents to project requirements

The Need for Commissioning

- Validate system installation to construction documents
- Collaboratively sign off on system startup and setup
- Current commissioning process is field based technical procedures
- Difference between system setup and commissioning
- Lower energy consumption
- Better quality—meeting an owner's expectation

Commissioning During Planning and Design

Caleb Nelson, P.E., LEED AP

CTA, Inc.

Commissioning During Planning and Design

Has the system been *designed* as required?

Commissioning During Planning and Design

CHAPTER OVERVIEW:

- Forming the *Cx Team*
- Process: *Scopes/Roles/Responsibilities*
- Developing the *OPR*
- Developing the *Cx Plan*
- Developing the *BoD*
- Requirements for *CDs*
- Managing the *Issues Log*
- Deliverables and Acceptance

Has the system been *designed* as required?

Commissioning During Planning and Design

Process

- OPR > BoD > CDs
- Deliverables
- Start Issues Log
- Feedback Loops
- Acceptance/Approval

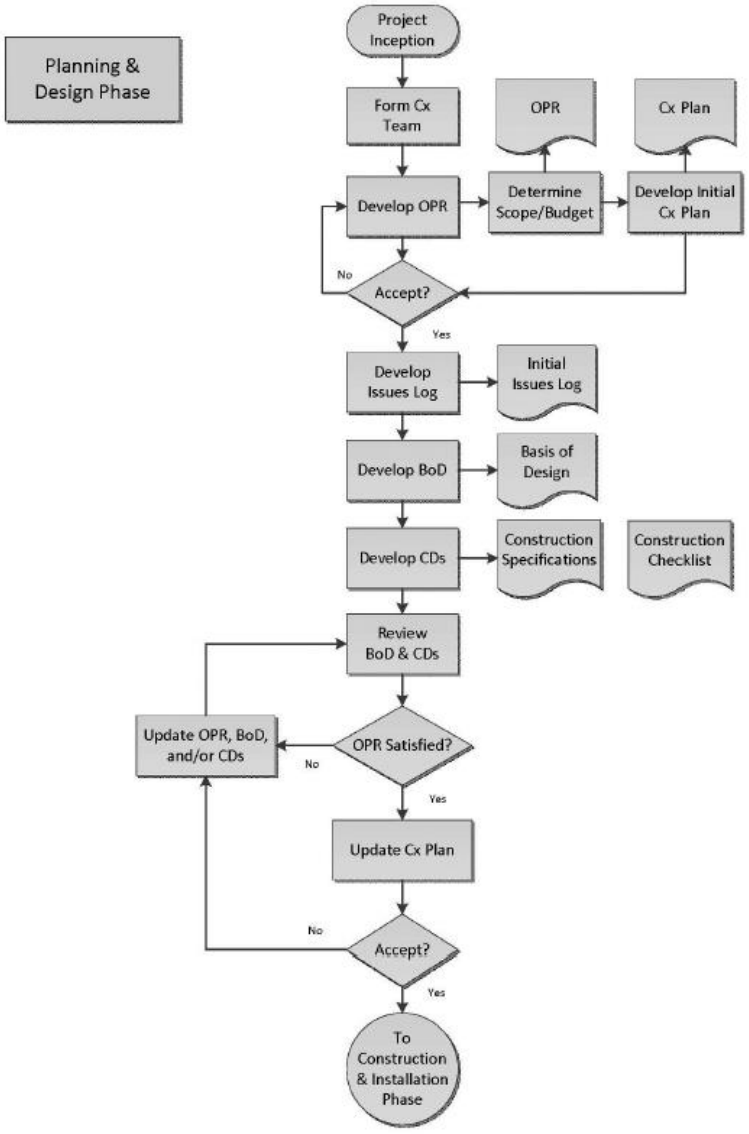


Figure 2-1 Planning and Design Commissioning Flowchart

Commissioning During Planning and Design

Forming the Cx Team

- Inherent to project team?
  - Owner,
  - REOR,
  - Contractor,
  - Manufacturer, etc…
- CxA? Who is it?

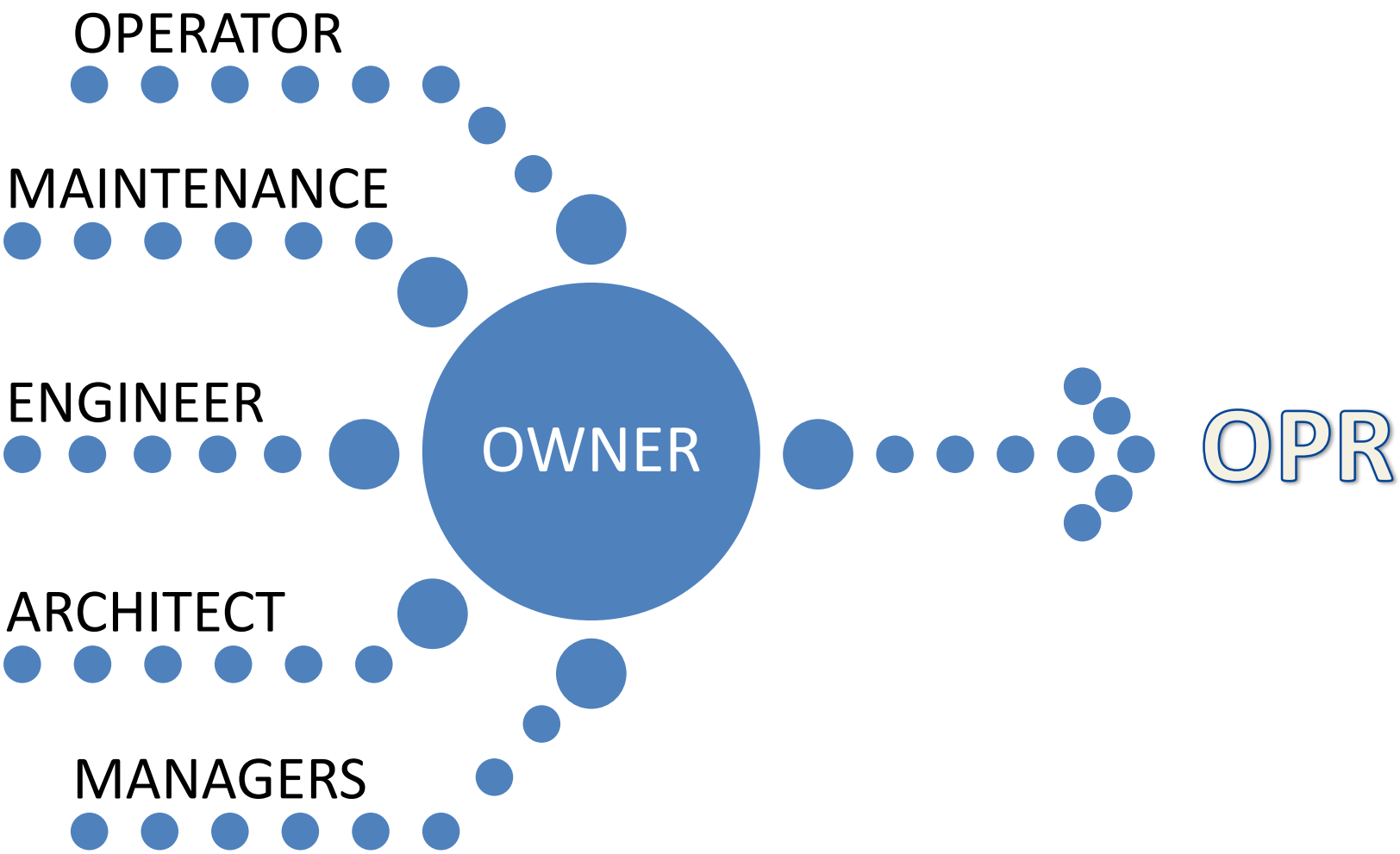
Commissioning During Planning and Design

Scope, Roles & Responsibilities

- Variety of ways to execute projects!
- There's flexibility but there must be an expectation set.
- EXAMPLES: Tables 2-1, 2-2 & Appendix A

Commissioning During Planning and Design

Developing the OPR



Commissioning During Planning and Design

Developing the OPR

BUDGET	SYSTEM TYPE	TEWI	CONSTRUCTABILITY
REDUNDANCY	ENERGY PERFORMANCE	REFRIGERANT CHARGE	COMMUNICATION
JURISDICTIONAL	VIBRATION	SOUND	POWER FAILURE RESILIENCE
LOAD MATCHING	SYSTEM INTEGRATION	LOAD CALC METHOD	REFRIGERANT MANAGEMENT

Commissioning During Planning and Design

Cx Plan

- Commissioning Plan guides overall commissioning process
- Developed after OPR is defined
- The “who, what, where, when, why *and sometimes how*”
- Includes:
  - Responsibilities
  - Communications
  - Activities/Technical procedures
  - Schedule/Timing
  - Document and reporting requirements
- Needed and active in every phase

Commissioning During Planning and Design

Basis of Design (BoD)

The BoD is “a document that records the concepts, calculations, decisions and product selections used to meet the OPR…”

Table 2-4 Example OPR and BoD Language

Example Requirements in the OPR		Corresponding Example Information in the BoD
Ambient temperatures used for design-day calculations are to be the “0.4% dry-bulb” temperatures as published by ASHRAE (*ASHRAE Handbook—Fundamentals*, 2013). Round 0.4% dry-bulb (db) temperature up to nearest 5 degree increment. Use evaporative-cooled technology when ambient temperature exceeds 105°F.	⇨	The 0.4% db temperature for Anywhere, USA = 92°F. The design-day ambient temperature used in design is therefore 95°F. Air-cooled condensers were selected because the calculated design ambient temperature does not exceed 105°F.

Commissioning During Planning and Design

Issues Log

Table 2-3 Example Issues Log—Electronic Version

#	Issue	Issue Description	Date Identified	Contractor Responsible	Date Contractor Notified	Action Taken	Issue Resolution (Open / Closed)	Date Resolved
1								
2								

"The issues log contains detailed descriptions of any design, installation and performance issues that are at variance with the OPR."

- Living document, established early and managed throughout project
- Transfer responsibility as needed
- Track issues from identification to closure
- **Should be allowed to affect future OPRs**

Commissioning During Planning and Design

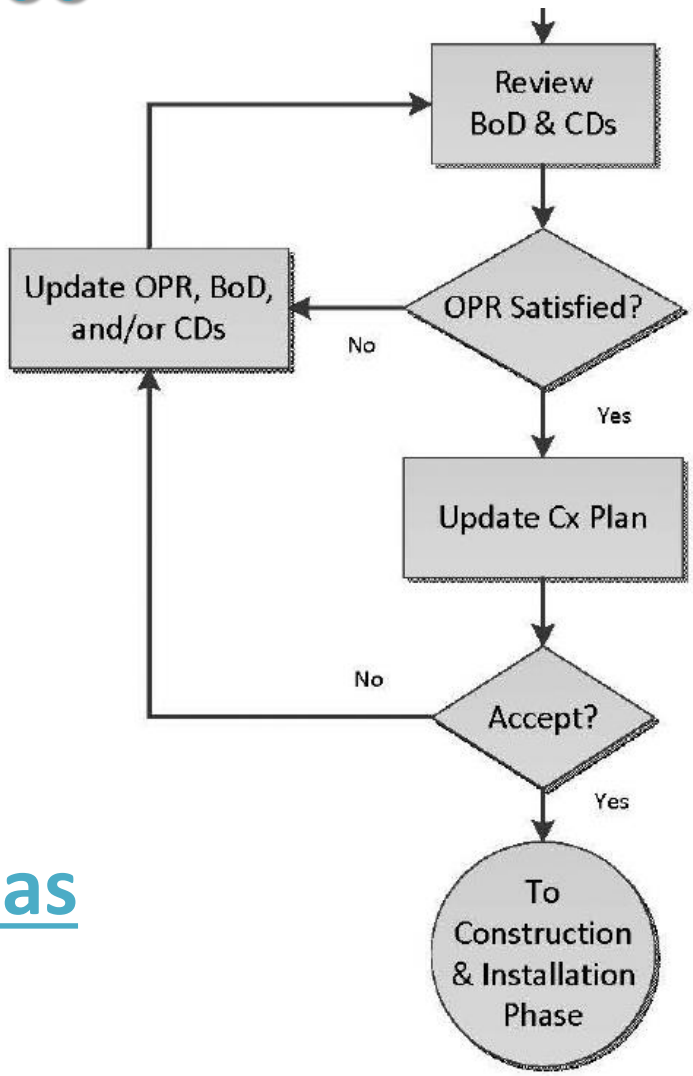
Requirements for CDs

- Designer responsibilities
  - Familiarity with Cx Plan so that any/all commissioning activities can be supported in CDs
- Sequence of Operation
- Specifications
  - Commissioning documents such as OPR, Cx Plan, R&R should be provided during bidding phases to allow for all Cx scope of work to be accounted for.
- CD's should be "commissioned"

Commissioning During Planning and Design

Deliverables and Acceptance

- Deliverables:
  - Commissioning Plan
  - Issues Log
  - OPR
  - BoD
  - CDs and Specifications
- Acceptance:



Has the system been *designed* as required?

Commissioning During Construction and Startup

Neil Monson

Engineering Manager
Target Corporation

Target Commissioning

Design

- Target Engineering maintains OPR and BOD documents for every critical engineered system
- Target has internal QAR teams to review drawings and evaluate external consultants
  - QAR focus is on design and functionality
  - Document quality is assessed but as a secondary function
  - QAR metrics are shared with consultants and determine assignments for future work

Procurement

- Target manages all procured, engineered systems so that all equipment is held to the same specification and alternates controlled.
- Equipment is inspected at delivery for damage and compliance with the construction documents.

Target Commissioning

Background

- In 2009, Target expanded its refrigeration footprint in our GM stores – Tested to failure early 2009
- Lack of installation consistency led to a strong focus on commissioning

Target Commissioning

Preparation (Training)

- Target trains each new GC and RC
- Materials cover
  - Onboarding
  - Business processes
  - Scheduling
  - Refrigeration specific best practices
- Target CxA (internal and external) have roles in this activity as support and trainers.
- Binders
- Flip Books

Target Commissioning

Training Areas of Importance

- Condensers and roof-top piping
- Refrigeration systems and mechanical rooms
- Hangers and piping
- Walk-Ins
- Cases
- Controls
- Startup

Target Commissioning

Training Materials

- Training presentations
  - Cover highlights of binders
- Binders
  - Hard copy of schedules, communications and best practices that stay on site
- Flip Books
  - Pocket references of details and what they really look like

Target Commissioning

Training Materials

Target Commissioning

Roles in Target Commissioning

- Target Engineer
- Target or Consultant Engineer
- Target Cx
- Target Operations
- Target Construction
- Target Refrigeration Authority (TRA)
- REMS Integrator

Target Commissioning

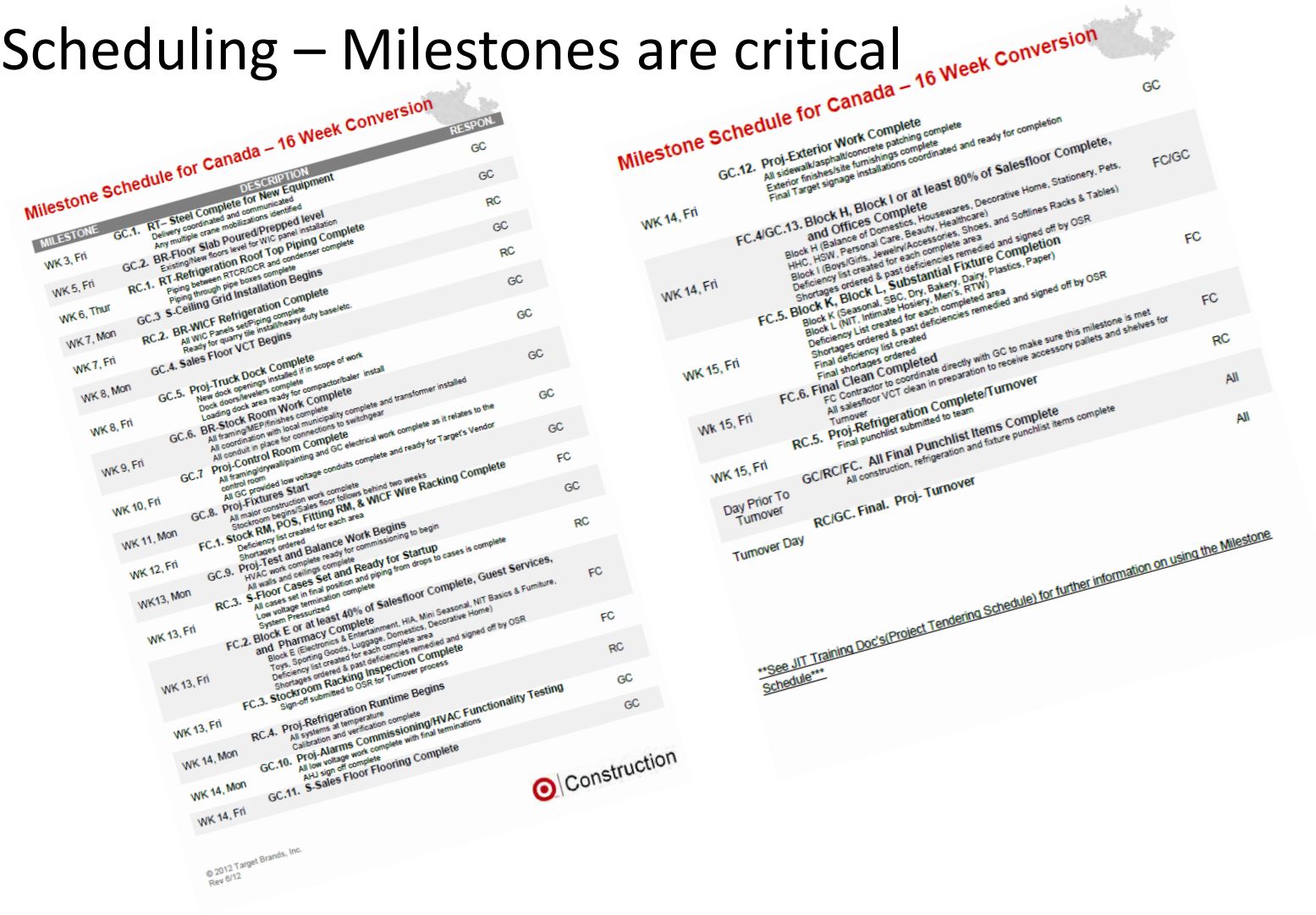
Construction

- Each project begins with the pre-mobilization meeting to ensure that there is understanding of:
  - Scope
  - Schedule
  - Communication loops
  - Commissioning responsibilities

Target Commissioning

Construction

- Scheduling – Milestones are critical



Milestone Schedule for Canada – 16 Week Conversion

MILESTONE	DESCRIPTION	RESPON.
WK 3, Fri	GC.1. RT– Steel Complete for New Equipment Delivery coordinated and communicated Any multiple crane mobilizations identified	GC
WK 5, Fri	GC.2. BR-Floor Slab Poured/Prepped level Existing/New floors level for WIC panel installation	GC
WK 6, Thur	RC.1. RT-Refrigeration Roof Top Piping Complete Piping between RTCR/DCR and condenser complete Piping through pipe boxes complete	RC
WK 7, Mon	GC.3 S.Ceiling Grid Installation Begins	GC
WK 7, Fri	RC.2. BR-WICF Refrigeration Complete All WIC Panels set/Piping complete Ready for quarry tile install/heavy duty base/etc.	GC
WK 8, Mon	GC.4. Sales Floor VCT Begins	GC
WK 8, Fri	GC.5. Proj-Truck Dock Complete New dock openings installed if in scope of work Dock doors/levelers complete Loading dock area ready for compactor/baler install	GC
WK 9, Fri	GC.6. BR-Stock Room Work Complete All framing/MEP/finishes complete All coordination with local municipality complete and transformer installed All conduit in place for connections to switchgear	GC
WK 10, Fri	GC.7 Proj-Control Room Complete All framing/drywall/painting and GC electrical work complete as it relates to the control room All GC provided low voltage conduits complete and ready for Target's Vendor	GC
WK 11, Mon	GC.8. Proj-Fixtures Start All major construction work complete Stockroom begins/Sales floor follows behind two weeks	FC
WK 12, Fri	FC.1. Stock RM, POS, Fitting RM, & WICF Wire Racking Complete Deficiency list created for each area Shortages ordered	GC
WK13, Mon	GC.9. Proj-Test and Balance Work Begins HVAC work complete ready for commissioning to begin All walls and ceilings complete	RC
WK 13, Fri	RC.3. S.Floor Cases Set and Ready for Startup All cases set in final position and piping from drops to cases is complete Low voltage termination complete System Pressurized	FC
WK 13, Fri	FC.2. Block E or at least 40% of Salesfloor Complete, Guest Services, and Pharmacy Complete Block E (Electronics & Entertainment, HIA, Mini Seasonal, NIT Basics & Furniture, Toys, Sporting Goods, Luggage, Domestics, Decorative Home) Deficiency list created for each complete area Shortages ordered & past deficiencies remedied and signed off by OSR	FC
WK 13, Fri	FC.3. Stockroom Racking Inspection Complete Sign-off submitted to OSR for Turnover process	RC
WK 13, Fri	RC.4. Proj-Refrigeration Runtime Begins All systems at temperature Calibration and verification complete	GC
WK 14, Mon	GC.10. Proj-Alarms Commissioning/HVAC Functionality Testing All low voltage work complete with final terminations AHJ sign off complete	GC
WK 14, Mon	GC.11. S.Sales Floor Flooring Complete	GC
WK 14, Fri	GC.12. Proj-Exterior Work Complete All sidewalk/asphalt/concrete patching complete Exterior finishes/site furnishings complete Final Target signage installations coordinated and ready for completion	GC
WK 14, Fri	FC.4/GC.13. Block H, Block I or at least 80% of Salesfloor Complete, and Offices Complete Block H (Balance of Domestics, Housewares, Decorative Home, Stationery, Pets, HHC, HSW, Personal Care, Beauty, Healthcare) Block I (Boys/Girls, Jewelry/Accessories, Shoes, and Softlines Racks & Tables) Deficiency list created for each complete area Deficiency list created for each complete area Shortages ordered & past deficiencies remedied and signed off by OSR	FC/GC
WK 15, Fri	FC.5. Block K, Block L, Substantial Fixture Completion Block K (Seasonal, SBC, Dry, Bakery, Dairy, Plastics, Paper) Block L (NIT, Intimate Hosiery, Men's, RTW) Deficiency List created for each completed area Shortages ordered & past deficiencies remedied and signed off by OSR Final deficiency list created Final shortages ordered	FC
Wk 15, Fri	FC.6. Final Clean Completed FC Contractor to coordinate directly with GC to make sure this milestone is met All salesfloor VCT clean in preparation to receive accessory pallets and shelves for Turnover	RC
WK 15, Fri	RC.5. Proj-Refrigeration Complete/Turnover Final punchlist submitted to team	All
Day Prior To Turnover	GC/RC/FC. All Final Punchlist Items Complete All construction, refrigeration and fixture punchlist items complete	All
Turnover Day	RC/GC. Final. Proj- Turnover	

See JIT Training Doc's(Project Tendering Schedule) for further information on using the Milestone Schedule*

Construction

Rev 6/12

Target Commissioning

On-Line Scheduling Tools

Refresh

			Project Group	Asset Group	Library Desc	Milestone	Owner	Sched Dt	Completed Dt	Status	Comments
		Clear		REFRIGERA							
			SEP-2013-CAN	REFRIGERAT	REFR	02|Walk In Cooler/Freezer Thermal Break Acceptance	REFR-TRA	2/22/2013	2/28/2013	ORG	Complete: Scheduled Date Mi... View history
			SEP-2013-CAN	REFRIGERAT	REFR	03|Back Room Plumbing Acceptance	REFR-TRA	3/8/2013	6/27/2013	ORG	Complete: Scheduled Date Mi... View history
			SEP-2013-CAN	REFRIGERAT	REFR	04|Back Room Electrical Acceptance	REFR-TRA	3/8/2013	6/27/2013	ORG	Complete: Scheduled Date Mi... View history
			SEP-2013-CAN	REFRIGERAT	REFR	05|Walk In Cooler/Freezer Acceptance	REFR-TRA	3/8/2013	6/27/2013	ORG	Complete: Scheduled Date Mi... View history
			SEP-2013-CAN	REFRIGERAT	REFR	05|WICF Acceptance	REFR-TRA	3/8/2013	3/8/2013	GRN	. View history
			SEP-2013-CAN	REFRIGERAT	REFR	01|Refrigeration Roof Top Piping Acceptance	REFR-TRA	4/15/2013	4/5/2013	GRN	View history
			SEP-2013-CAN	REFRIGERAT	REFR	06|Sales Floor Overhead Piping/Evacuations Acceptance	REFR-TRA	6/7/2013	4/12/2013	GRN	View history
			SEP-2013-CAN	REFRIGERAT	REFR	07|Sales Floor Electrical Acceptance	REFR-TRA	6/14/2013	6/26/2013	ORG	Date changed wrong store View history
			SEP-2013-CAN	REFRIGERAT	REFR	08|Rack & Cases Evacuated & Ready for Start-Up	REFR-TRA	6/17/2013	6/26/2013	ORG	. View history
			SEP-2013-CAN	REFRIGERAT	REFR	11|REMS Remote Connectivity	Cx-INSTALL	7/22/2013	7/15/2013	GRN	View history
			SEP-2013-CAN	REFRIGERAT	REFR	12|Refrigeration Asset Transitioned	Cx-INSTALL	7/22/2013	8/8/2013	ORG	Complete: Scheduled Date Mi... View history
			SEP-2013-CAN	REFRIGERAT	REFR	09|Refrigeration Unit Startup Acceptance	REFR-TRA	7/26/2013	7/22/2013	GRN	Corrected dates View history
			SEP-2013-CAN	REFRIGERAT	REFR	10|Refrigeration Runtime Acceptance	REFR-TRA	7/26/2013	7/25/2013	GRN	Changed wrong store View history

Refresh

Target Commissioning

Checklists

Target Commissioning

HOME | Unit Check | Reading | Note | Issue | Log | 28 total Unit Check tab records.

T3652

Assigned Pr

T3652-P0

ARCH

	Category	Parameter Step	Primary Data	
			Value (50)	Units (50)
1	Unit Da			
2				
3				
4				
5				
6				
7				
8				
9	Constru			
10				
11				
12				
13				
14				
15				

	Category	Parameter Step	Primary Data	
			Value (50)	Units (50)
16		All pull-up access covers on the case line-up are properly installed.	Pass	
17		Installation of all applicable fascia, trim, bumper and color band parts, raceway covers, kick-plates, and close-off panels are complete.	Pass	
18		Case condensate pan drain piping installation is complete and verified free of obstructions, with minimum 1/4-inch per foot pipe slope in the direction of flow, no pipe size reductions and water seals in place.	Pass	
19		Refrigeration piping installation complete	Pass	
20		Refrigerant circuit piping leak testing is successfully complete with any leaks found repaired.	Pass	
21		All plug-in electrical connections have been checked for positive seal.	Pass	
22		Case lighting operational, with all wire terminations verified tight, electrical covers in place and shipping tape removed from fluorescent lamps.	Pass	
23		Anti-sweat heaters are operational with all wire terminations verified tight and electrical covers in place.	Pass	
24		Case fans are operational, with all wire terminations verified tight, electrical covers in place and fan bracket bolts checked for tightness.	Pass	
25		Case temperature sensor wiring is complete to the supply and defrost termination sensors of each case, with all wire terminations verified tight, control points checked, and electrical covers in place.	Pass	

Target Commissioning

Checklists

- Thermal breaks and vapor barriers correct before panels go up
- Panels properly sealed
- Units level and properly supported
- Correct piping, nitrogen use
  - Cut out fittings and inspect
- Correct insulation
  - Thickness and fitting use

Target Commissioning

Systemic Issues Log

- Same tool that tracks Milestones and Checklists
- Field makes reports of what they think might be systemic issues
- Target Team evaluates and makes determination

Target Commissioning

Pre-Functional Testing

- Ensures that systems are ready to be started up and commissioned
  - Pressure testing
  - Evacuations
  - Sensor verifications
  - REMS power and communications

“Commission As You Go”

- Commission overhead piping before the ceiling goes back in
- Commission WICF sealing before pulling down

Target Commissioning

Start-Up

- Start-Up Activities and Reports
  - Target consolidates all start-up scope and reports into one Specification Section (24 9000)

1.5 START-UP

A. Refrigeration start-up process is comprised of three formal parts. Pre-start-up testing, performance verification and validation activities:

1. Pre-Start-Up Phase:
   a. Part 1 – Delivery verification: Inspect delivered equipment upon arrival for inconsistencies with refrigeration design documents and damage. Coordinate with refrigeration equipment supplier to correct any deficiencies.
   b. Part 2 – Pre-Start-Up: Verify that systems have been properly installed and are ready for start-up.
2. Performance Verification Phase: Systems are made operational by refrigeration contractor prior to onsite visit by manufacturer representative. Charge systems in accord with specifications and begin start-up process. Contractor start-up should be scheduled so that systems are operational before equipment manufacturer representative site visit for validation phase. Formally document these pre-start-up and performance verification activities on the following and submit to Target:
   a. Refrigeration Pre-Start-up/Start-Up Report.
3. Validation Phase: System performance is reviewed by a commissioning agent and equipment manufacturer representatives with assistance from refrigeration contractor. Formally document these performance reviews on the following and submit to Target:
   a. Rooftop Compressor Rack Validation Report.
   b. Commissioning agent's formal workbook report.

Target Commissioning

3.2 PRE-START-UP

A. For condensing unit only stores, document all pre-start-up information on Refrigeration Acceptance Inspection Report.

B. For R TCR and CU stores, document all pre-start-up information on Refrigeration Pre-Start-up/Start-up Report

C. Che
with

D. Che
requ

E. Che

F. Ene

G. Veri

H. Veri

I. Veri

J. Veri

K. Veri

L. Veri

M. Veri

N. Veri

O. Veri

P. Veri

Q. Veri

R. Veri

S. Veri

T. Verify that compressor discharge service valve is fully open.

3.5 START UP

A. Follow manufacturer's published start up procedures.

B. Test
Refri

C. Start
repre

D. Inclu
servi
refrig

E. Char
100
temp

F. Start
1. V
a

b
c

G. Keep

H. Keep

I. Activ

3.8 EVAPORATIVE CONDENSER START-UP

A. Evacuate evaporative condensers and associated piping prior to adding refrigerant charge. Refer to Sections 24 2315 and 24 0110.

B. Verify line voltage and check motor rotation prior to operation.

C. Verify line voltage to the chemical water treatment panel.

D. Operate equipment controls and safeties to verify proper function. Adjust valves and controls to place evaporati condensers in full operation.

E. Verify that motor amperages, air flow rates, and water flow for evaporative condensers agree with manufacturer' data.

F. RC to coordinate validation of chemical water treatment system with McMillan Inc. or water treatment supplier two weeks prior to start-up:

McMillan Water Treatment Inc.
Doug Potts/Jon Ingebrigtsen
PO Box 1539
8450 Tamarind Ave Suite D
Fontana, CA 92335
PH: 909-428-3760

G. Include written start-up reports identifying valve positions, controls test, electrical test results, waterflow, and airflow. Refer to Section 24 0110.

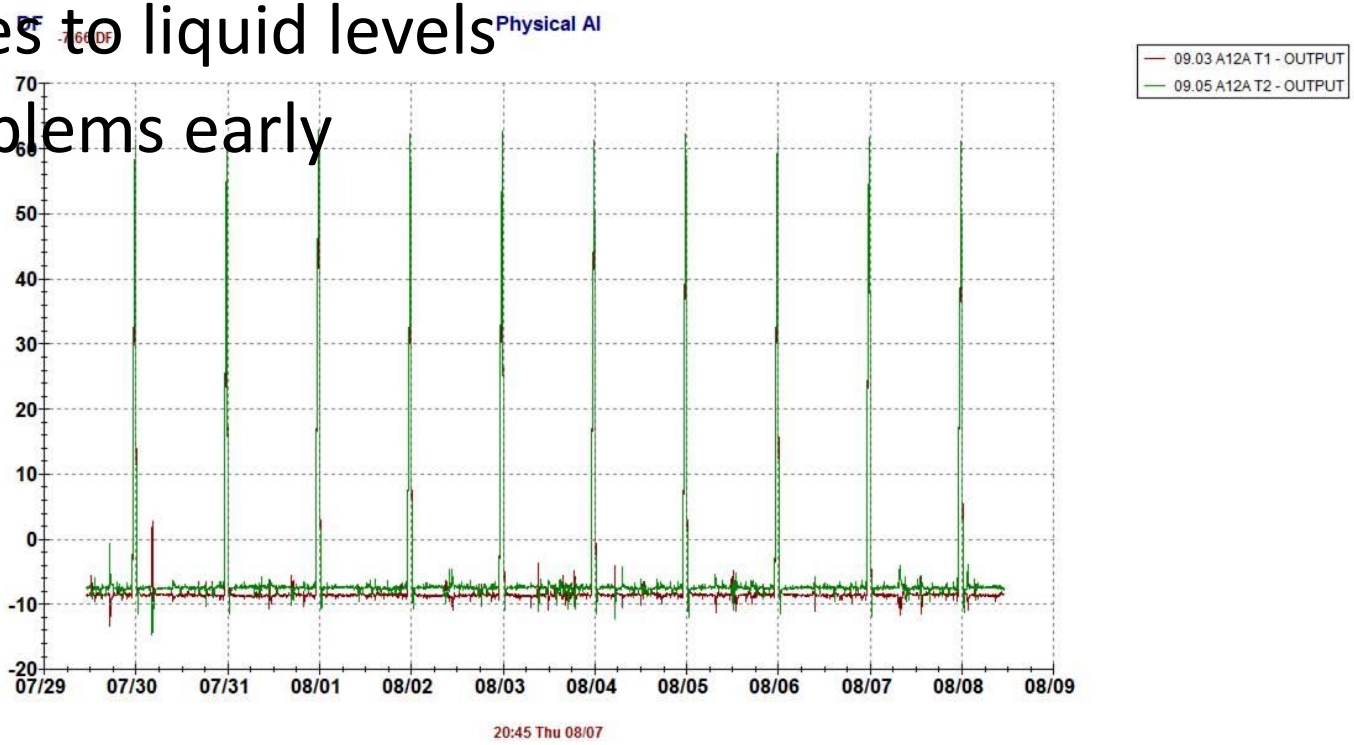
Target Commissioning

Start-Up

- Reports

Trending

- Use the REMS to trend everything from case temperatures to liquid levels
- Identify problems early



Target Retro-Commissioning

Stores that are operating poorly or have never been commissioned

- Identified by M&R spend
  - Dollars and **type** of M&R spend. High compressor failures, refrigerant leaks
  - What can the store afford (sales)
  - Energy spend above benchmark store(s)
- Vetting process
- Tools

Target Retro-Commissioning

Process

- Surveyed – Mobility tools for the Operations Team
- Scoped – Each store gets a unique RCx SOW from a common frame work
  - Refrigerant conversions might be included
  - Engineering review for conversions
- Sourced – Approved contractors only, competitive bidding

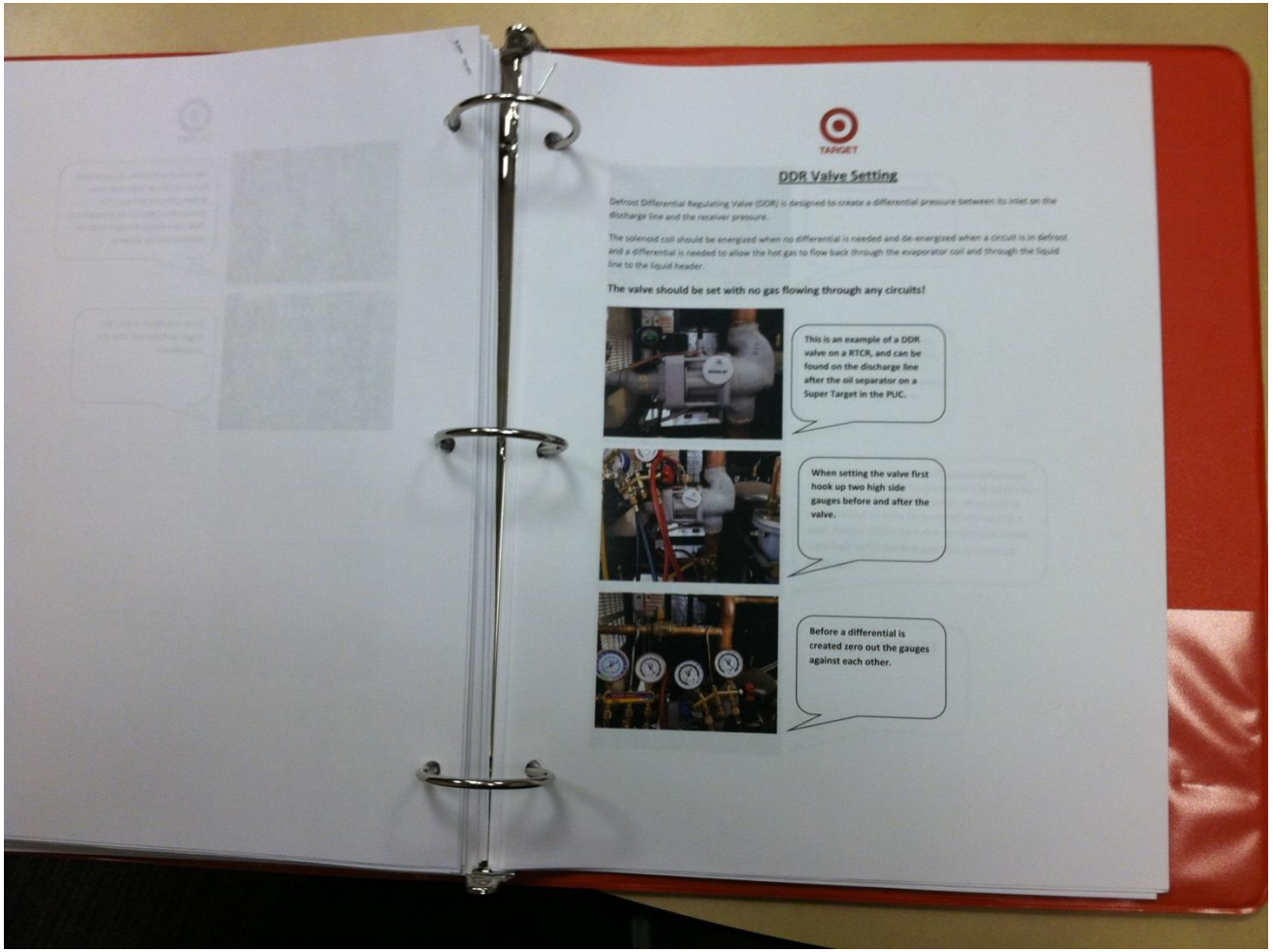
Target Retro-Commissioning

Documentation

- RCx Scope of Work
- Daily Log
- Checklists
- Technical Manual - How we want things done
  - Contractor changes
  - Oil removal
  - Case cleaning
  - Valves (DDR, Superheat, OLDR)
  - Refrigeration Operating Guidelines

Target Retro-Commissioning

Technical Manual



Target Retro-Commissioning

Execution

- Week 1 – Prep work
  - Oil systems changes, leak checks/repairs, valve changes/additions
- Week 2 – Conversion (if applicable)
- Week 3 – Final RCx
  - REMS sensors
  - Final adjustments
  - Final leak checks
  - Valve settings

Target Retro-Commissioning

Closeout

- Final walk with TLS (Operations) and contractor
- Punch list
- Data and Tracking

Results

- 20-25 per year
- Average M&R reduction of 60%-80%
- WO counts reduced also

Target Retro-Commissioning

Goal

- RCx then implement Required Maintenance (RM) plan
- Data Driven
  - Focus on where the M&R issues are
- RM plans are “RCx As You Go”
  - Condensers
  - Refrigeration System
  - Case maintenance

Cx During Startup & First Year

- Warranty (Warranty Period?)
- Benchmarking (At what conditions?)
- System Capacity (At what conditions?)
- Sequence of Operation (OK at all conditions?)
- Part Load (Low Ambient?)
- Training Requirements (Was the training effective?)

Can't do it all at startup!

Cx During Startup & First Year (CH 4)

ISSUES WITHIN THE FIRST YEAR—A CASE STUDY

Background: A supermarket was to be built in a cold, northern location in the U.S. and the owner wished to use evaporative condensing technology for the refrigeration system. The owner's direction was followed and the compressor rack was designed to use a close-coupled evaporative condenser that was to be located inside the compressor room and ducted through the roof. In a last-minute change, the owner decided to use a roof-mounted air-cooled condenser instead. This design change was implemented, but the compressor rack had already been built per the original design and shipped to the site. At this point, it was the contractor's responsibility to upsize a compressor to gain the additional capacity needed to operate at higher condensing temperatures. The contractor installed the necessary head pressure control valves to maintain the system's minimum condensing temperature in the wintertime. The system was then fully installed and started up.

Problem: The store's grand opening was scheduled for early fall and the system was installed and verified to be performing as required. As winter approached, the store personnel noticed that some of the cases were running warm. The service technician that diagnosed the issue (a separate entity from the installing contractor) noticed a low-level alarm in the liquid receiver. All the "extra" liquid in the receiver was being used to flood the condenser, which left the receiver essentially empty and starved the expansion valves at the evaporators. The service technician took the most logical step at the time, which was to fill the receiver with additional refrigerant to gain the proper levels. The result of this fix was that the system began performing as required once again.

The system continued to run well until the first hot spring day. This time the service technician noticed elevated head pressures. Upon further investigation it was determined that the root issue was that the receiver on the rack was actually too small, as suggested by the fact that it was completely full of liquid. It had originally been sized for a close-coupled evaporative condenser with no allowance for flooding an air-cooled condenser (and a long drain pipe) in the winter. In the warmer months, when the condenser needed to fully drain to achieve maximum capacity, there was not enough volume in the receiver to hold the extra refrigerant that was added in the winter. Finally, the contractor upsized the receiver and corrected the issue permanently.

Lessons Learned: The primary lesson to be learned is that just because the system runs well at start-up does not mean that it will continue to run well over time. Issues that arise in the first year or later will not always represent new or independent issues—many times these issues will be directly connected to the original design or installation of the system.

Another observation is that there was no CxA involved in this project and that the contractor who installed and started up the system was released from the job shortly after the store opened. Knowledge of the changes during construction was lost when the contractor left, so the service technician was not able to address the root problem during his initial servicing of the system in the winter. Instead, the system was not effectively fixed in the winter, which led to both the need for additional servicing and to additional loss of product in the spring.

Questions?

Thank you all for attending and FMI for hosting this session